SPECS-PREFACE workshop on initial shock, drift and systematic error

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SEVENTH FRAMEWORK PROGRAMME

SPECS Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

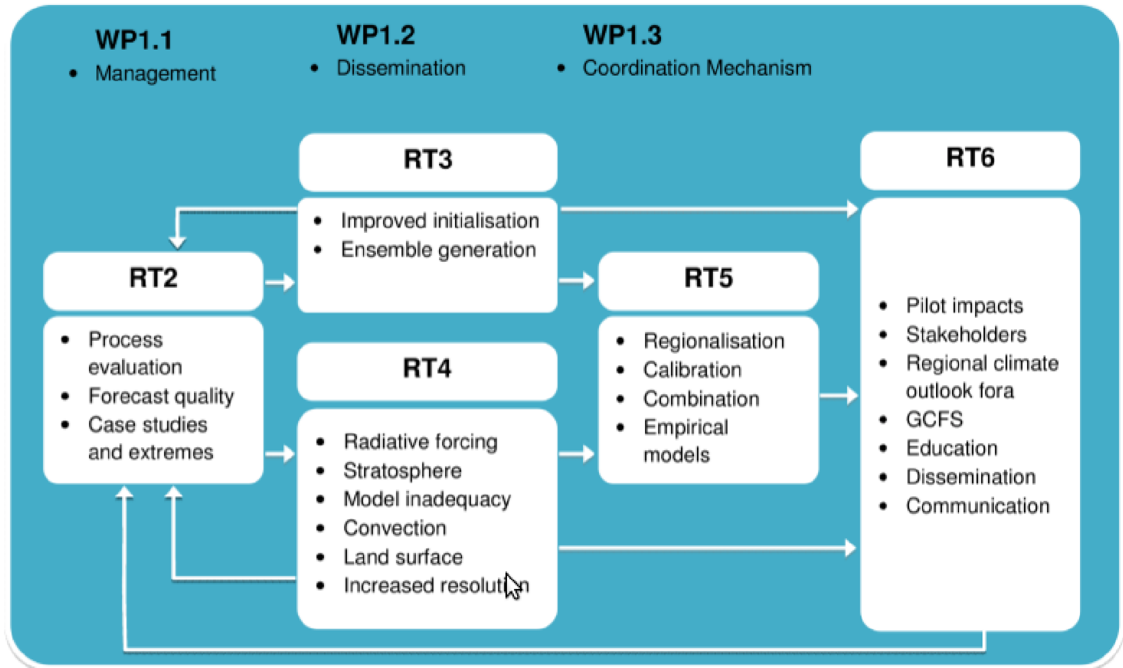
Motivation

- Objective: discussing developments in initial shock, drift and systematic error assessment in climate prediction; despite the work in the identification of model biases, little was done in understanding the causes of the initial shock and drift and in how to reduce their impact on forecasts.
- Questions:
  - What are the physical processes responsible for the model drift and the initial shock?
  - How to best characterize the drift and initial shock?
  - How to suggest model improvements that reduce the drift and how is this linked to the efforts to reduce the systematic error?
  - How does the initialisation strategy influence the skill?
  - How to deal with the drift and the systematic error a posteriori and the need for bias correction?
- 16 attendants, 10 speakers, 5 hours of discussion

SPECS FP7

SPECS will deliver *a new generation of European climate forecast systems, including initialised Earth System Models (ESMs) and efficient regionalisation tools to produce quasi-operational and actionable local climate information over land at seasonal-to-decadal time scales with improved forecast quality and a focus on extreme climate events, and provide an enhanced communication protocol and services to satisfy the climate information needs of a wide range of public and private stakeholders*.

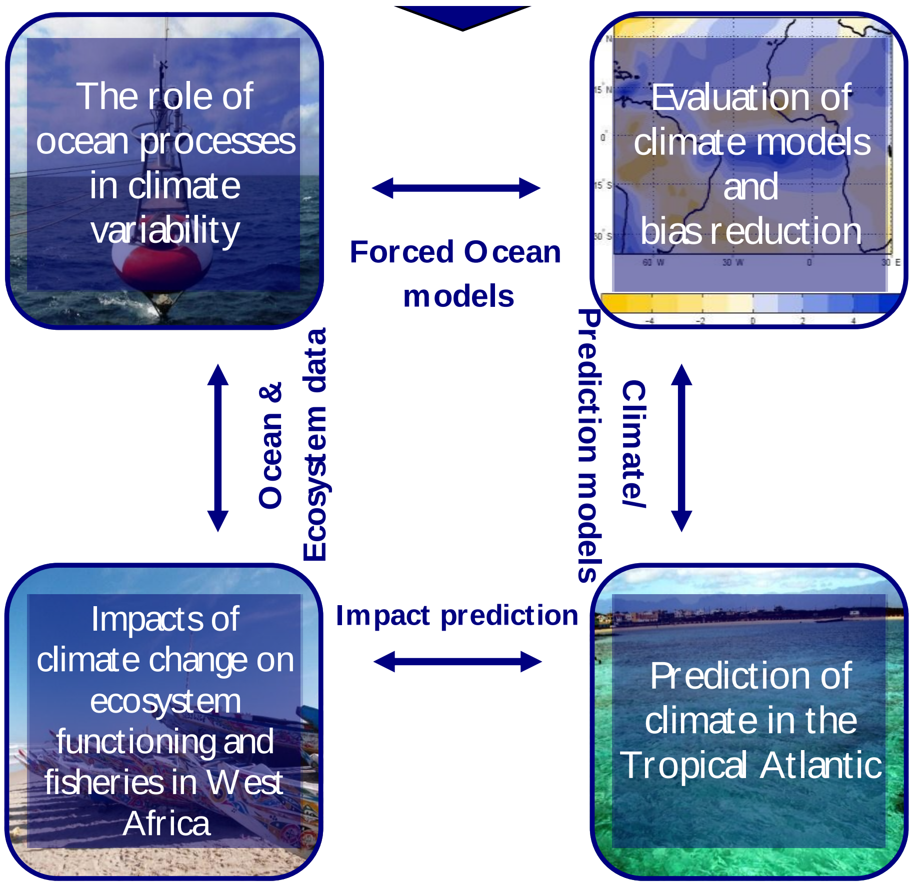
Forecast System	Project Partners
CNRM-CM5	CNRM, CERFACS
EC-Earth	KNMI, SMHI, IC3, ENEA
IFS/NEMO	ECMWF, UOXF
IPSL-CM5	CNRS
MPI-ESM	MPG, UniHH
UM	UKMET

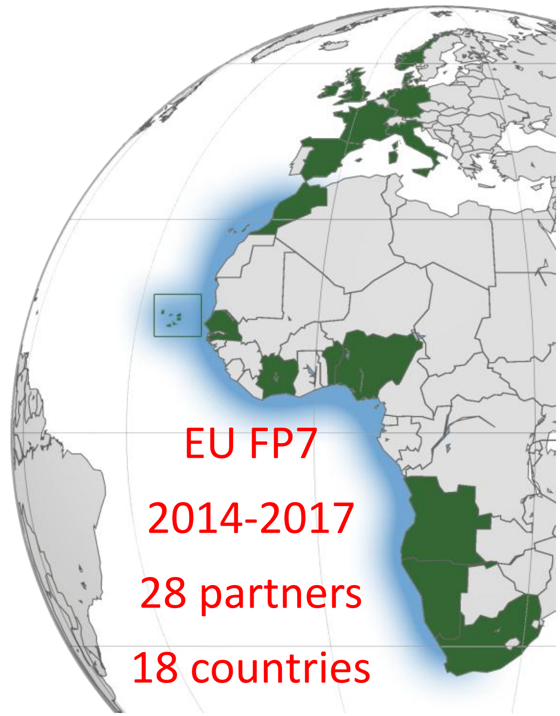


WP1.1: Management
WP1.2: Dissemination
WP1.3: Coordination across EUPORIAS, NACLIM & SPECS
RT2: Evaluation of current s2d forecast systems
RT3: Forecast strategies
RT4: Improved systems
RT5: Calibrated predictions at the local scale

PREFACE FP7

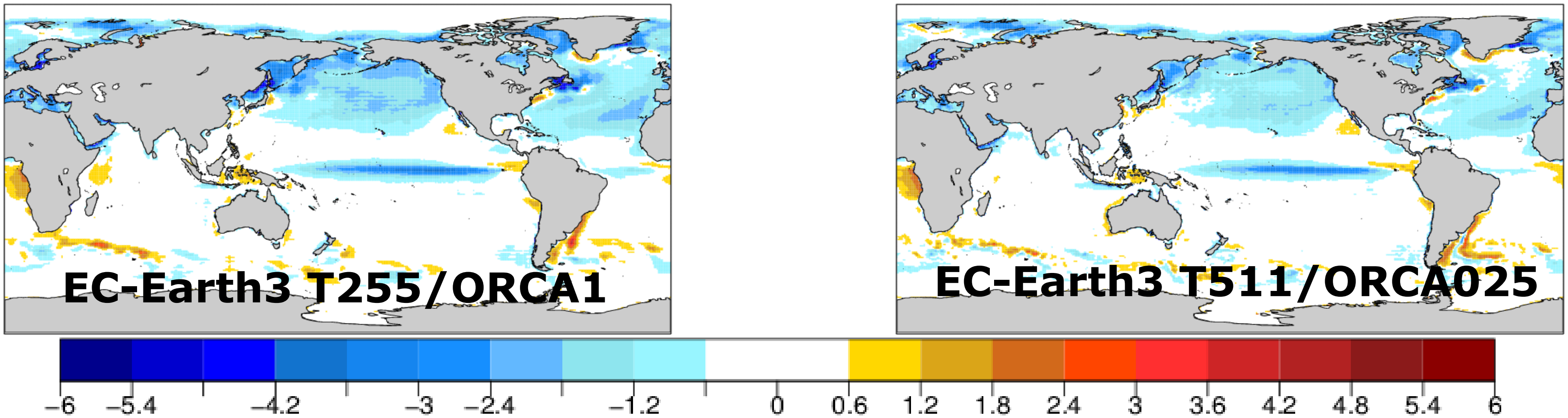
To improve climate prediction in the Tropical Atlantic to a level where socio-economic benefit can be realised, with focus on sustainable management of marine ecosystems and fisheries. Among the objectives "to enhance climate modelling and prediction capabilities".

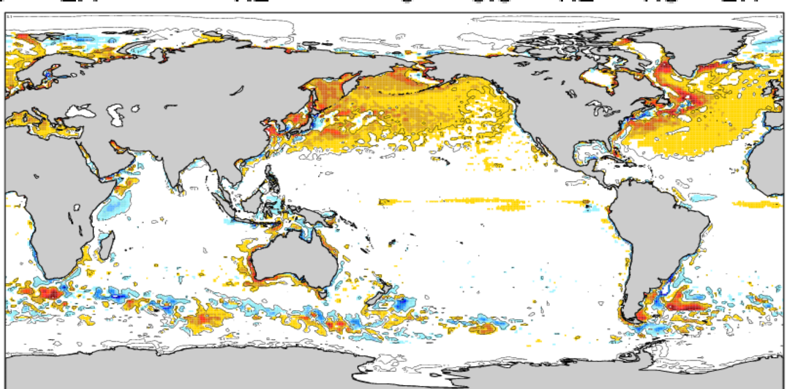




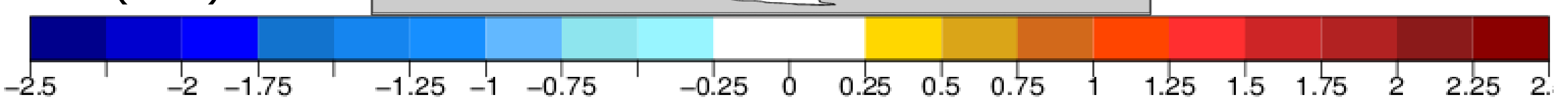
Reducing systematic error: resolution

Mean SST (K) systematic error versus ERAInt for JJA one-month lead predictions of EC-Earth3 T255/ORCA1 and T511/ORCA025. May start dates over 1993-2009 using ERA-Interim and GLORYS initial conditions.



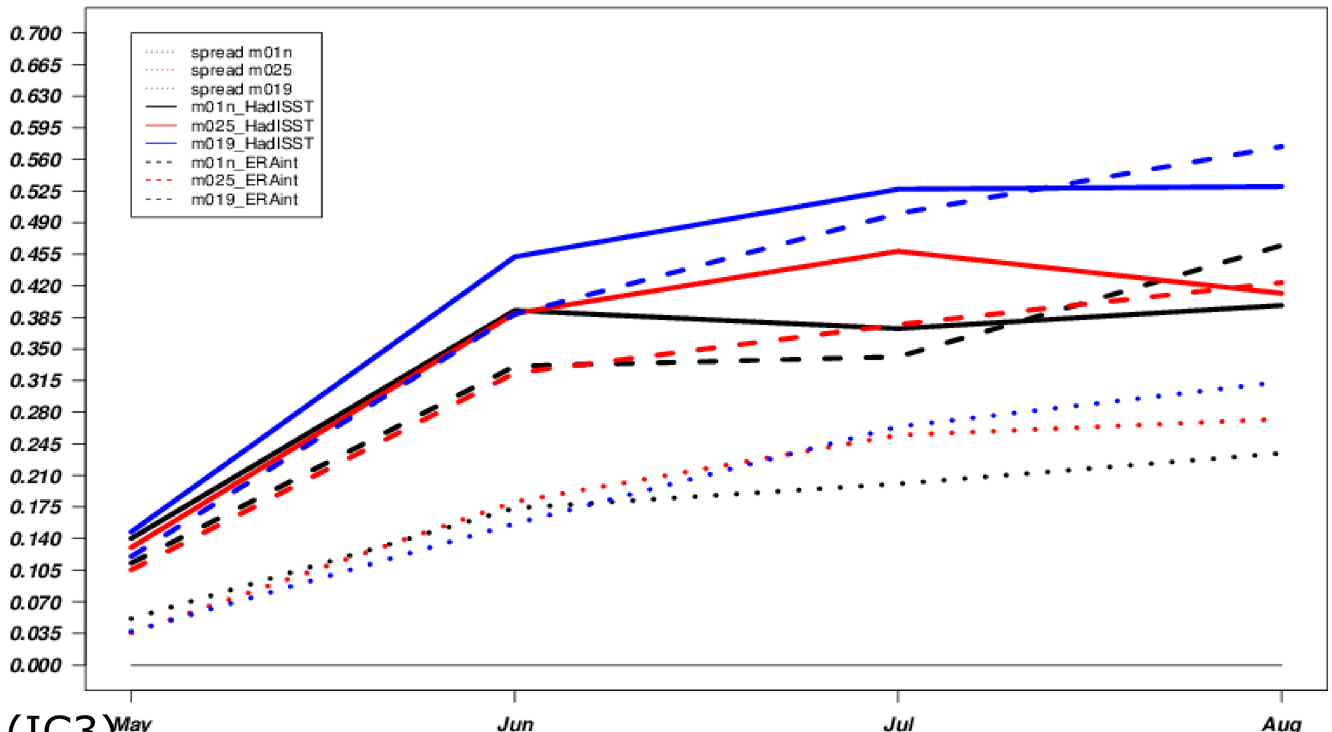


C. Prodhomme (IC3)



Reducing systematic error: resolution

RMSE and spread of Niño3.4 SST (versus HadISST-solid and ERAInt-dashed) from four-month EC-Earth3 simulations: **T255/ORCA1**, **T255/ORCA025** and **T511/ORCA025**. May start dates over 1993-2009 using ERA-Interim and GLORYS initial conditions and ten-member ensembles.

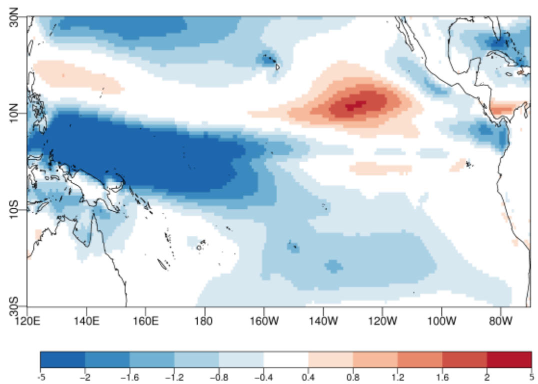


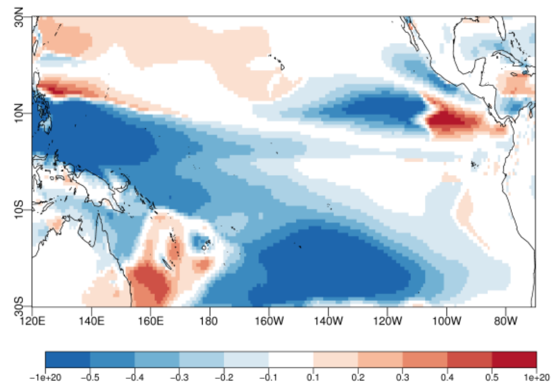
C. Prodhomme (IC3)

Reducing systematic error: stochastic physics

10-metre zonal wind JJA systematic error (versus ERAInt) and error reduction from EC-Earth3 simulations: standard resolution (**SR**, **T255/ORCA1**), high resolution (**HR**, **T511/ORCA025**) without and with stochastic physics (**SPPT3**). May start dates over 1993-2009 using ERA-Interim and GLORYS and ten-member ensembles.

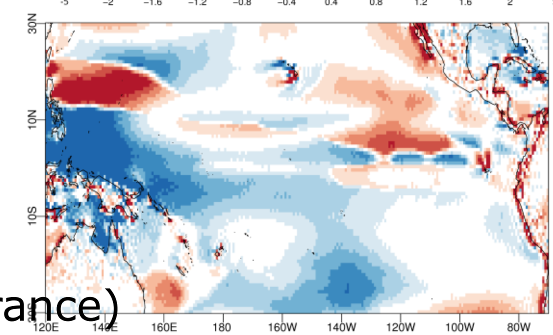
SR systematic error

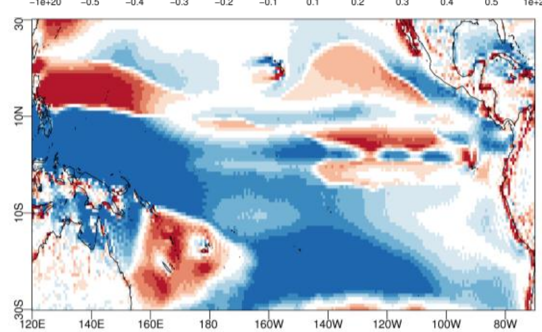




SR SPPT3 error reduction

HR systematic error





HR SPPT3 error reduction

L. Batté (Météo-France)

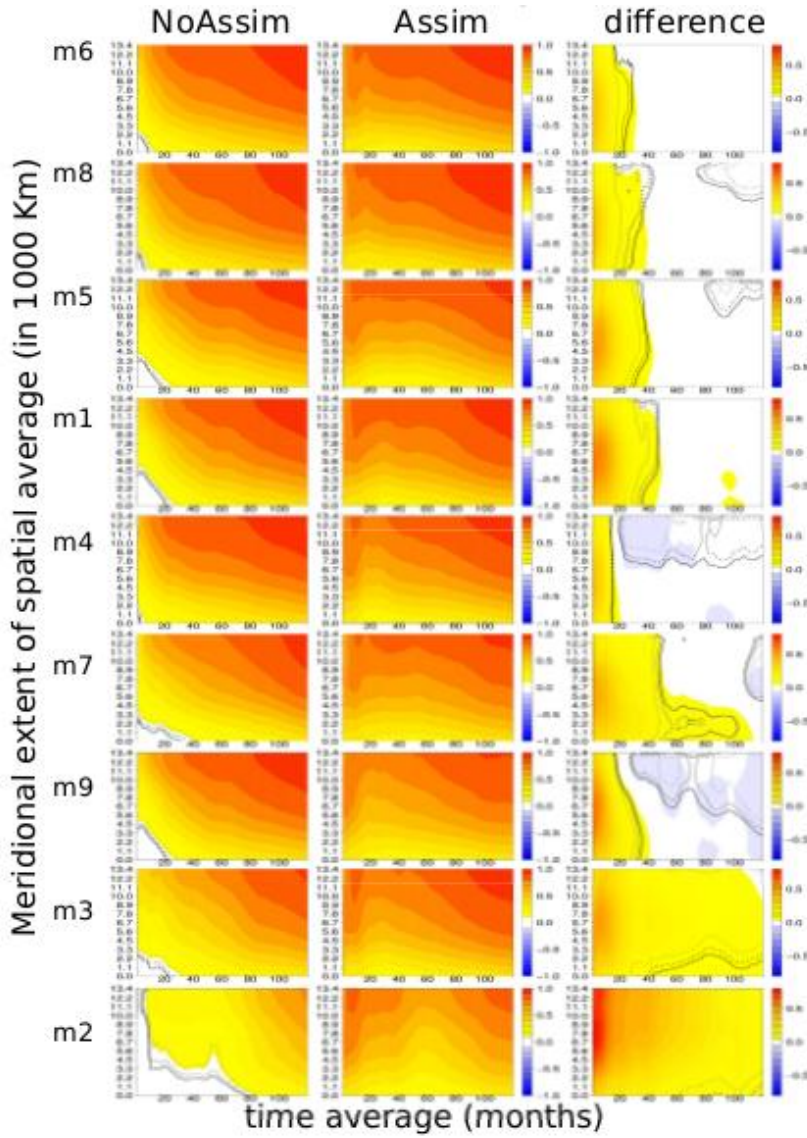
Sensitivity of skill to model response

Correlation of the ensemble-mean for near-surface air temperature of the DePreSys_PP (centre) Assim, (left) NoAssim and (right) their difference as a function of the integration along the forecast time (horizontal) and the space (vertical axis).

Each line for a version of DePreSys_PP, ranked in decreasing order of the slope of the linear trend of the NoAssim GMST.

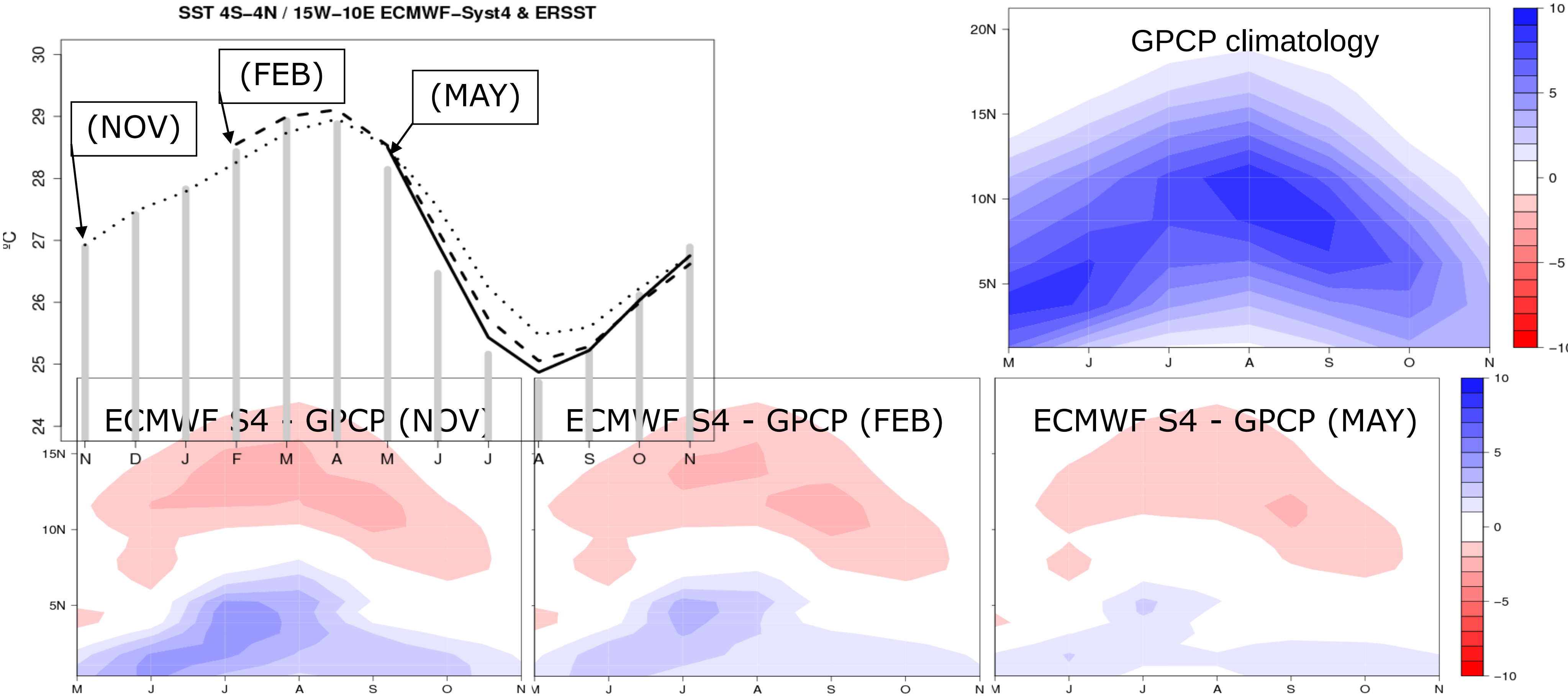
Hindcasts over 1960-2005 have been used and the reference dataset is NCEP R1. Black lines represent the confidence interval for the correlation differences.

Volpi et al. (2013)



Drift: WAM precipitation

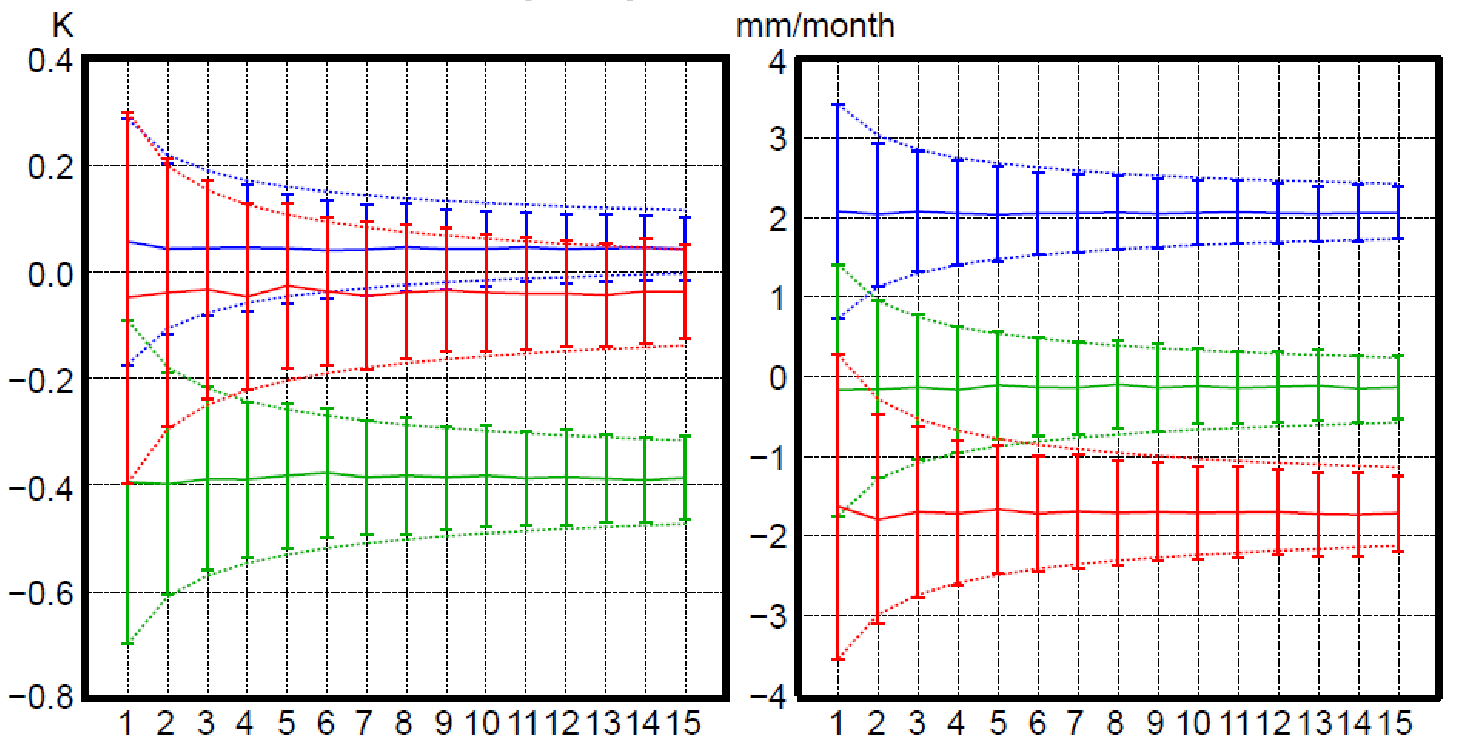
Averaged precipitation over 10ºW-10ºE for 1982-2008 for GPCP (climatology) and ECMWF System 4 (systematic error) with start dates November (6-month lead time), February (3) and May (0).



Doblas-Reyes et al. (2013)

Robustness of the drift

Drift for the ECMWF System4 forecasts for European temperature and precipitation in February with different start dates and forecast times: second minus first month (blue), fourth minus second month (green) and seventh minus fourth month (red).

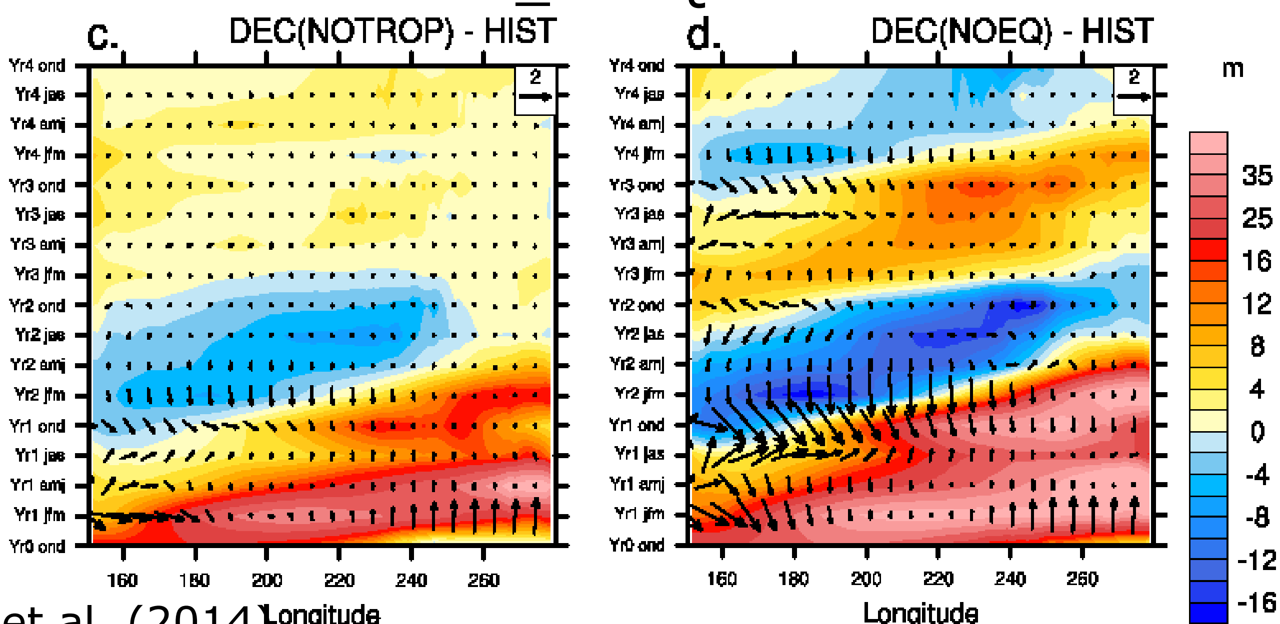


$dFeb_{FT1,FT0}$ $dFeb_{FT3,FT1}$ $dFeb_{FT6,FT3}$

Manzanas et al. (2014)

Origins of the drift: initial imbalance

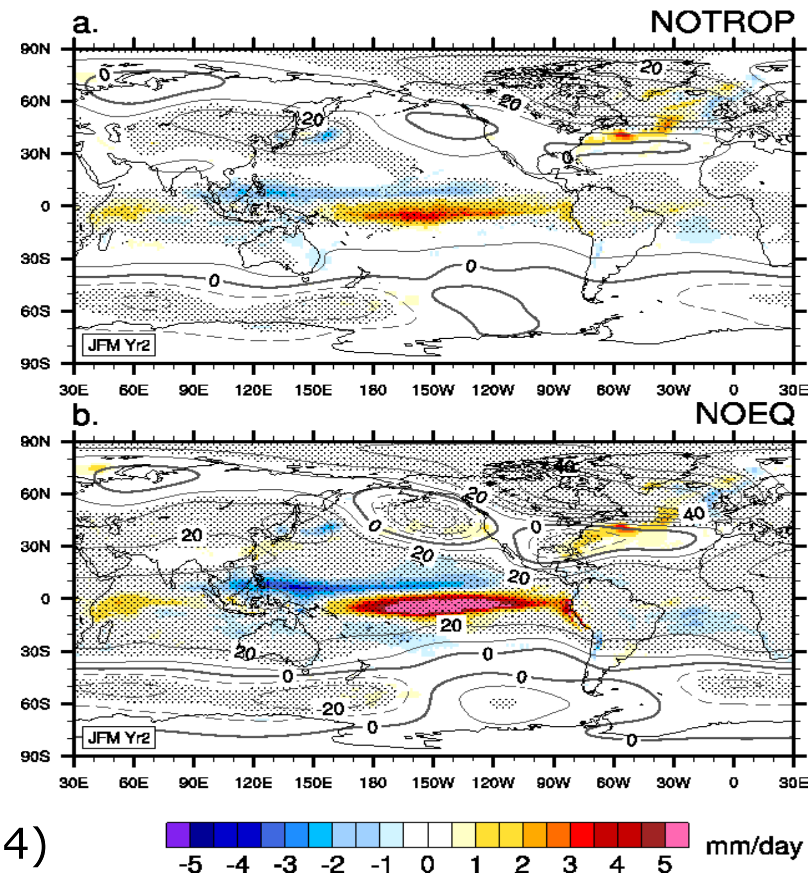
Lead-time (from OND Year 0 to OND Year 3) versus longitude for (c) DEC_NOTROP-HIST and (d) DEC_NOEQ-HIST seasonal means differences of the 20ºC isotherm depth (colours) and 10-meter winds (arrows) over 2ºS-2ºN. Contour interval every 2 metres and arrow units given in the upper-right corner (m s-1). Start dates every five years over 1960-2005. **The first year of the forecasts shows a quasi-systematic excitation of ENSO warm events,** an efficient way to rapidly adjust to its own mean state. This is worse in DEC_NOEQ.



Sánchez-Gómez et al. (2014)

Origins of the drift: initial imbalance

Z500 (contours) and precipitation (shading) differences between hindcasts initialised from (a) NOTROP_IC and (b) from NOEQ_IC, and HIST at forecast time JFM Year2. Gray hatching stands for Z500 significance at 95%. Contour and shading intervals are 10 metres and 0.5 mm/day.



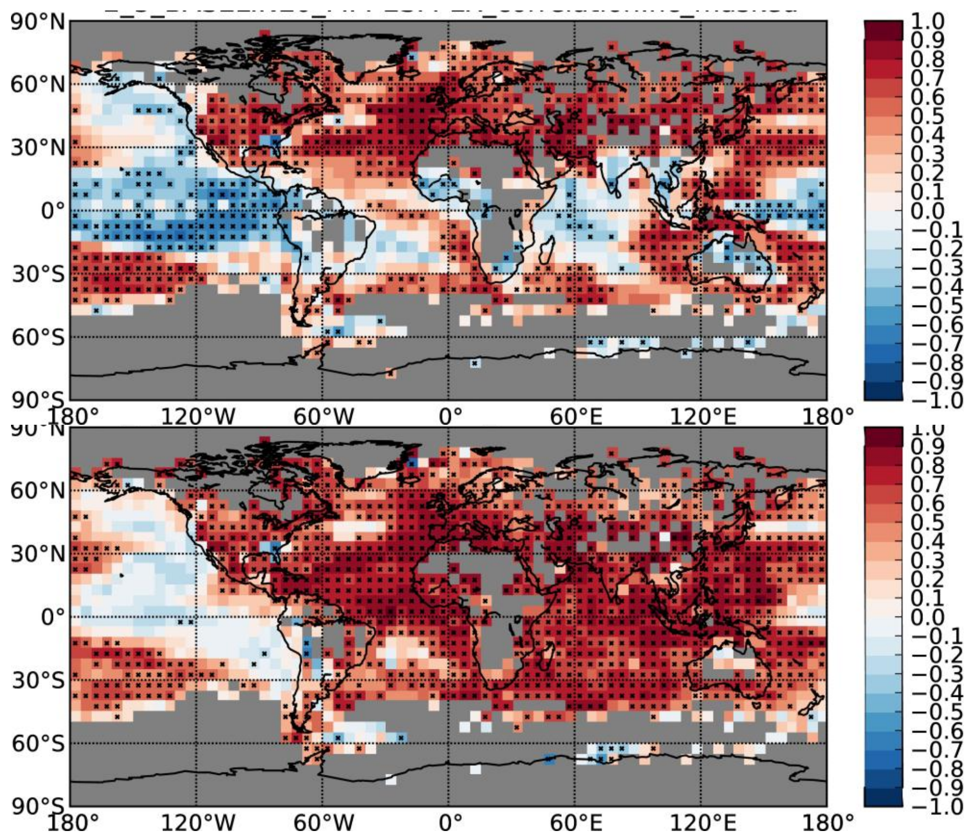
Sánchez-Gómez et al. (2014)

Origins of the drift: spurious trends in ics.

Correlation of the ensemble mean 2-5 year hindcasts of surface temperature performed with the MPI-OM system over 1961-2012 using (top) CMIP5 (ocean forced with NCEP/NCAR reanalysis) and (bottom) MiKlip (nudging towards ORAS4) initial conditions. Change in the negative skill over the tropical Pacific, even using the same climate model.

CMIP5

MiKlip system

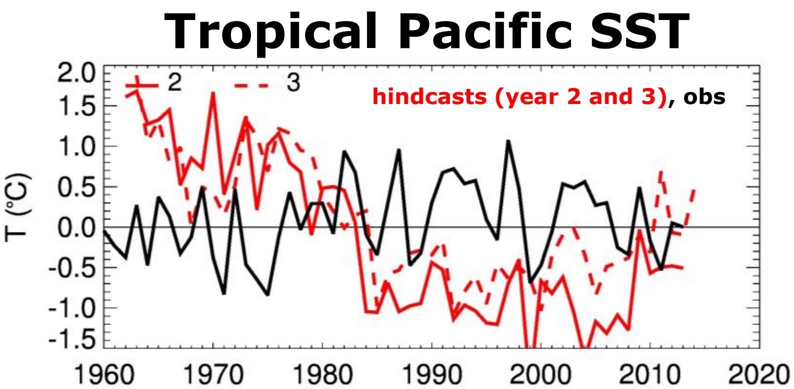


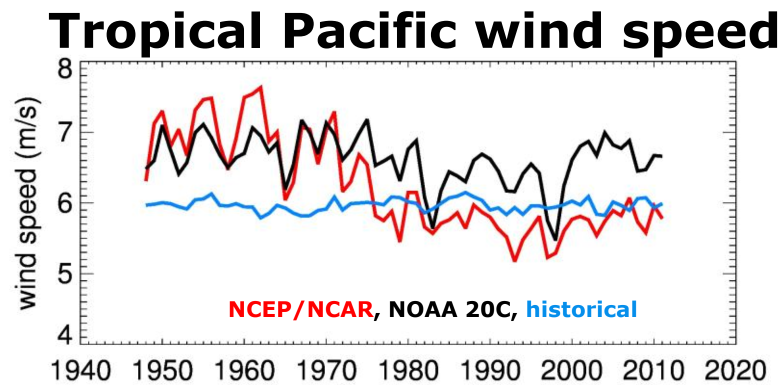
Pohlmann et al. (2013)

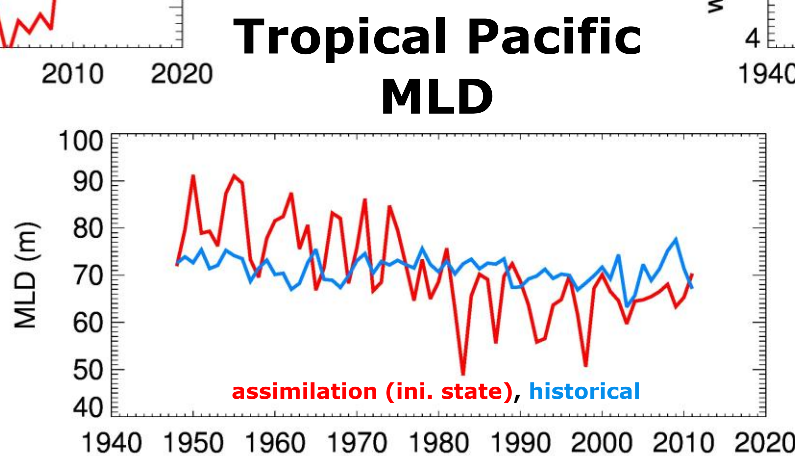
FONA Decadal Climate Prediction BMBF MiKlip

Origins of the drift: spurious trends in ics.

Hindcasts and analyses used in the MPI-OM system for CMIP5 (ocean forced with NCEP/NCAR reanalysis). Suspicious trend in NCEP/NCAR winds leading to trend in mixed layer depth.







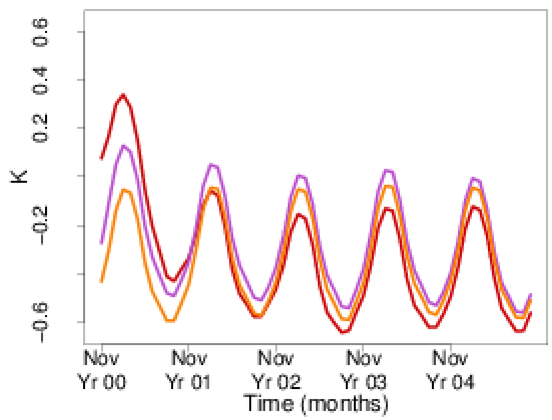
Pohlmann et al. (2013)

FONA Decadal Climate Prediction BMBF MiKlip

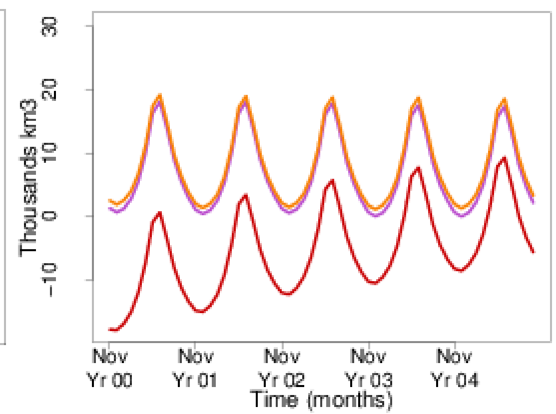
Anomaly and full-field initialisation

Assessment of full-field (red) and anomaly (purple, anomalies only in the ocean and sea ice) initialisation with EC-Earth2.3 to determine the influence of the drift on the forecast quality. Comparison with historical ensemble simulation (orange).

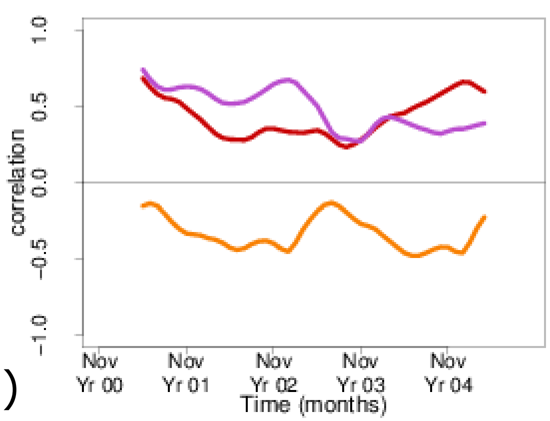
Global SST drift



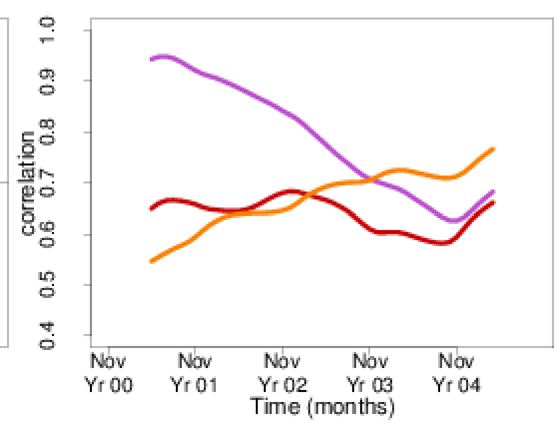
Sea-ice volume drift



AMV correlation



Sea-ice volume correlation



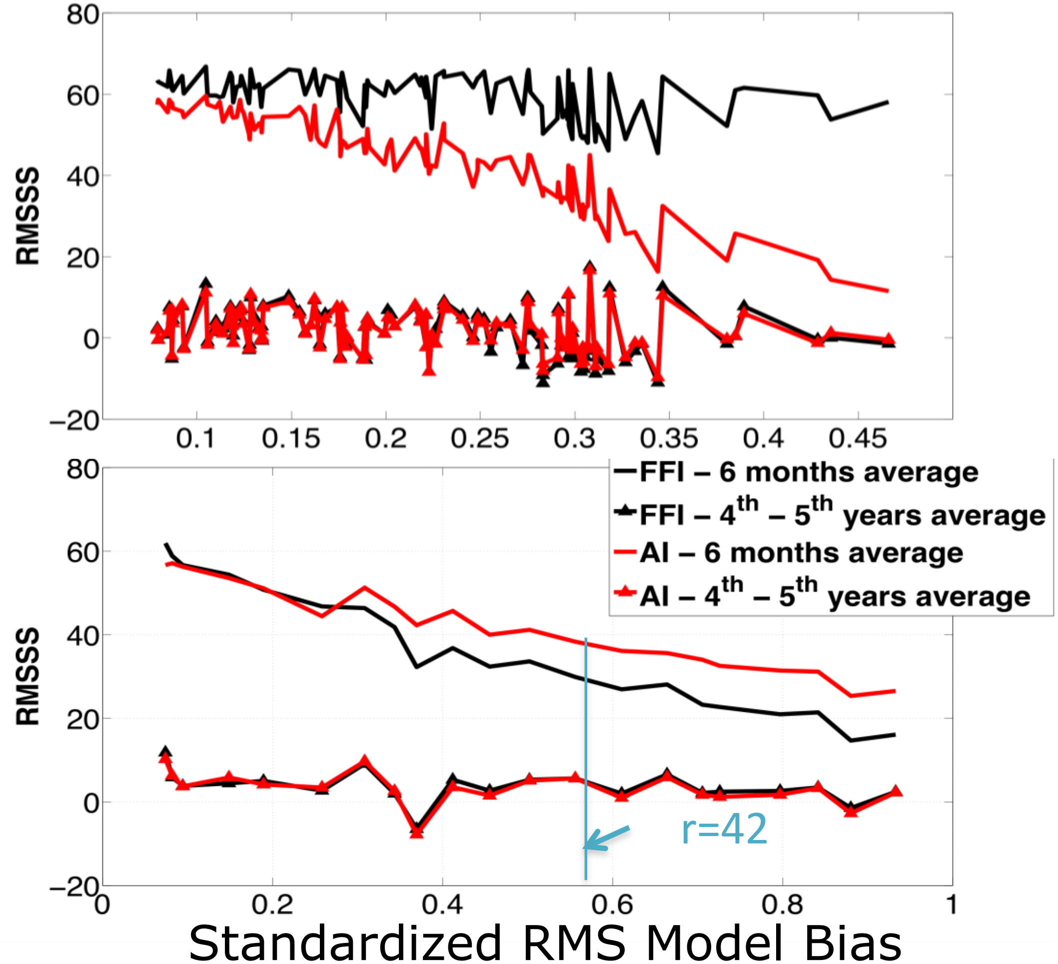
D. Volpi PhD (2014)

AI/FFI in a simple model

RMSSS of all variables (normalised by their standard deviation) from 360 decadal predictions performed with the 9-variable Lorenz model with three coupled compartments (ocean, tropical atmosphere and extratropical atmosphere).

Model configurations with erroneous atmosphere-ocean coupling parameters c, c_z

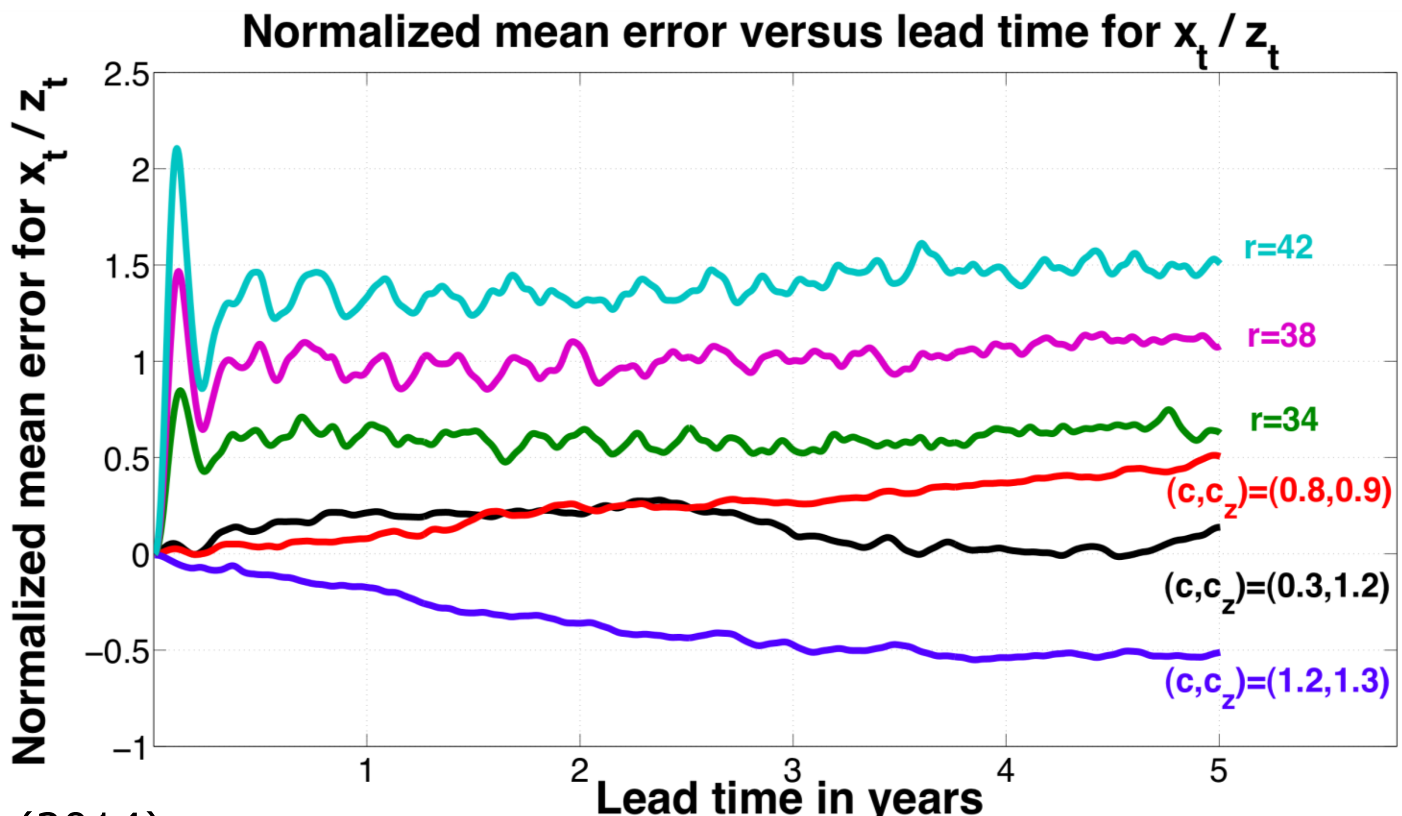
Model configurations with erroneous forcing parameter *r*



Carrassi et al. (2014)

AI/FFI in a simple model

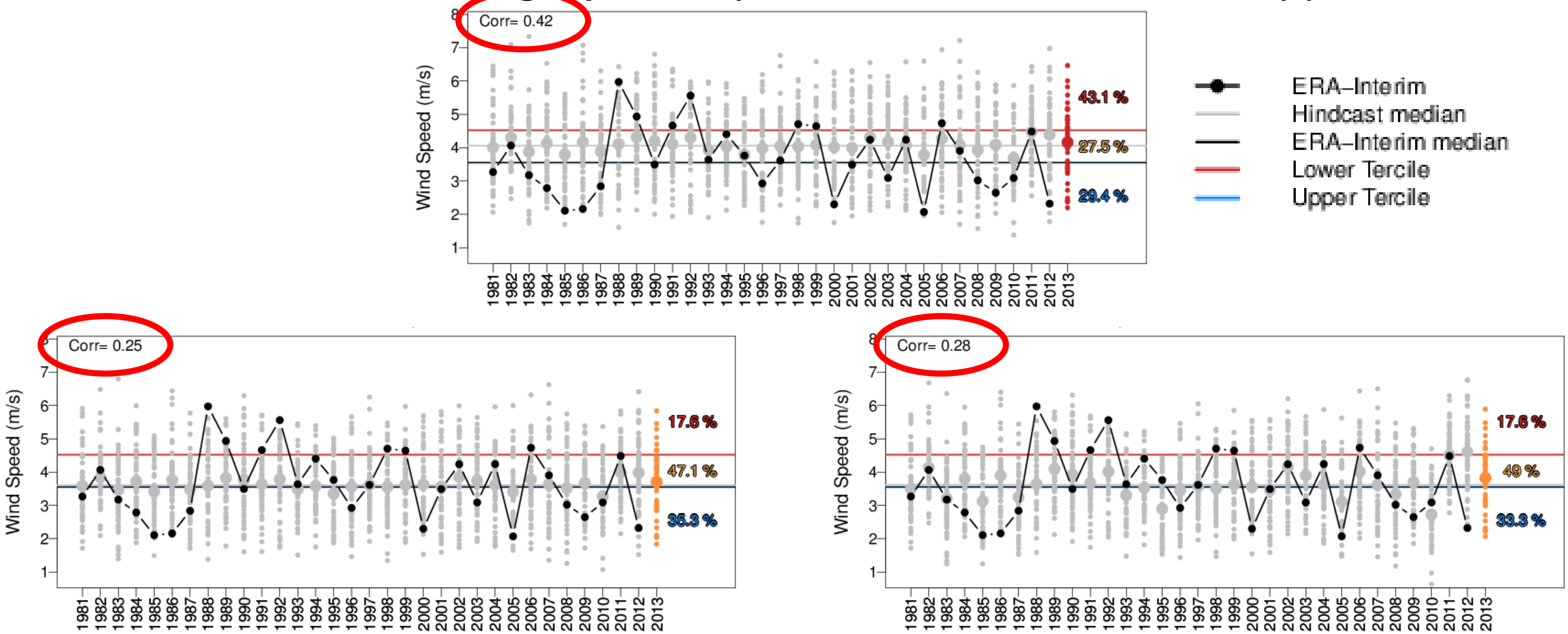
Mean error of two variables from 360 decadal predictions performed with the Lorenz model with three compartments (ocean, tropical atmosphere and extratropical atmosphere). The configurations where AI outperforms FFI are associated with a strong initial shock and a larger bias.



Carrassi et al. (2014)

Bias correction and calibration

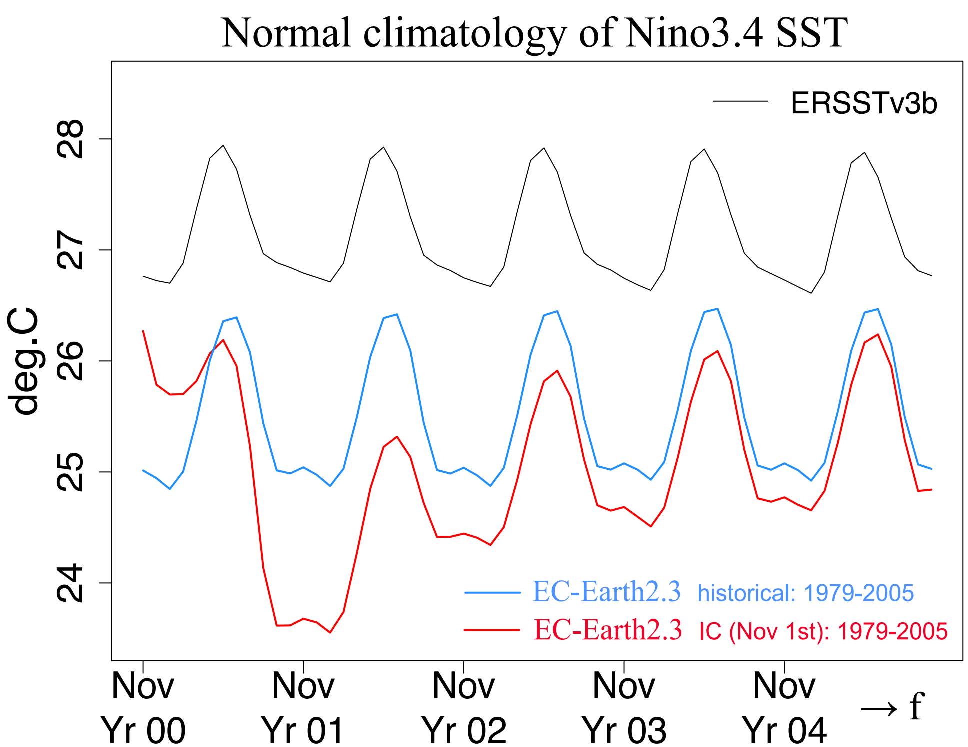
Bias correction and calibration have different effects. ECMWF S4 predictions of 10 m wind speed over the North Sea for DJF starting in November. Raw output (top), bias corrected (simple scaling, left) and ensemble calibration (right). One-year-out cross-validation applied.

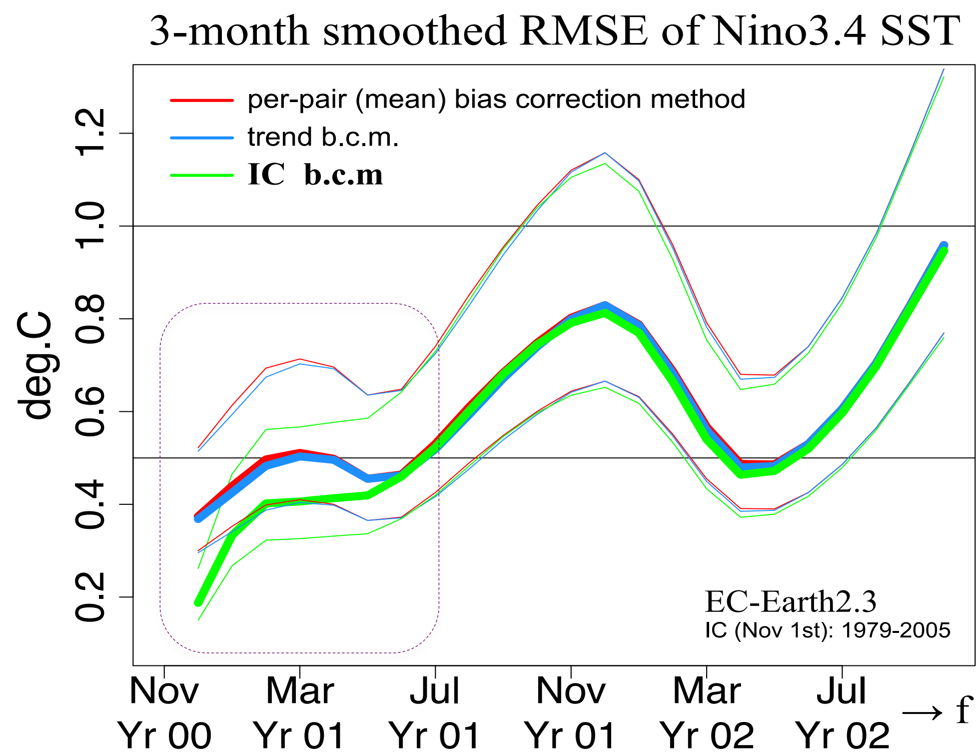


V. Torralba (IC3)

Bias correction and calibration

Bias correction where the forecasts are linearly regressed on a proxy estimate of the observed initial conditions for each forecast month. The RMSE of the initial-condition bias-correction method (green) is compared with the standard per-pair method (red) and the trend correction method (blue). The illustration uses the EC-Earth2.3 CMIP5 decadal hindcasts.

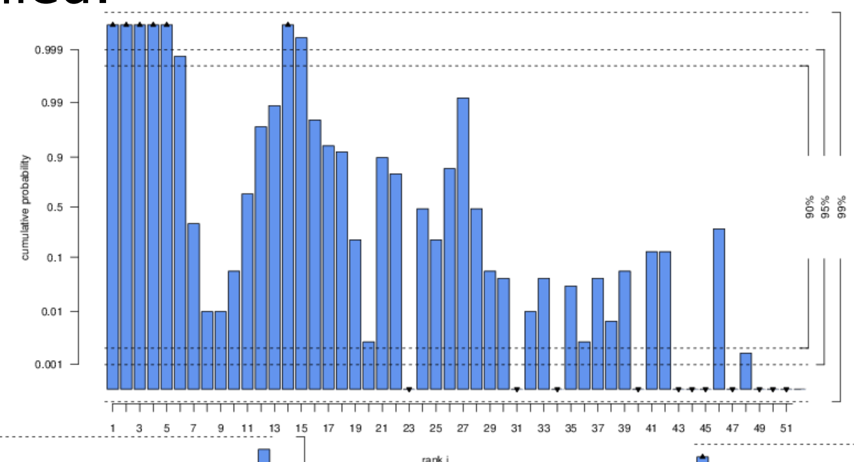


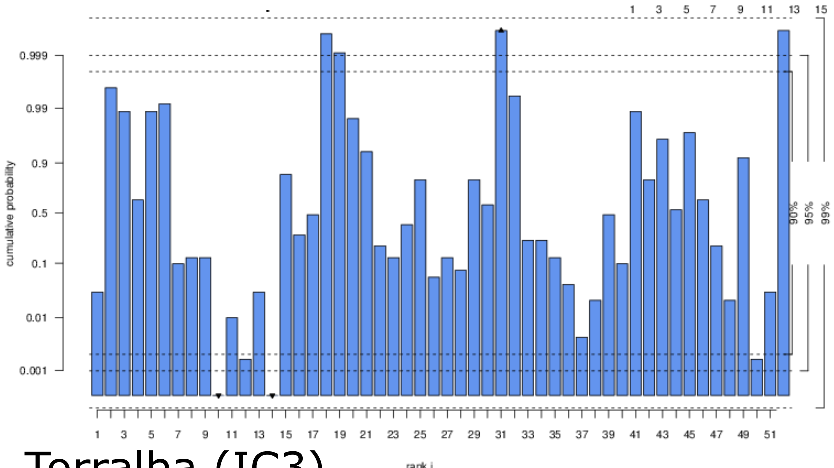


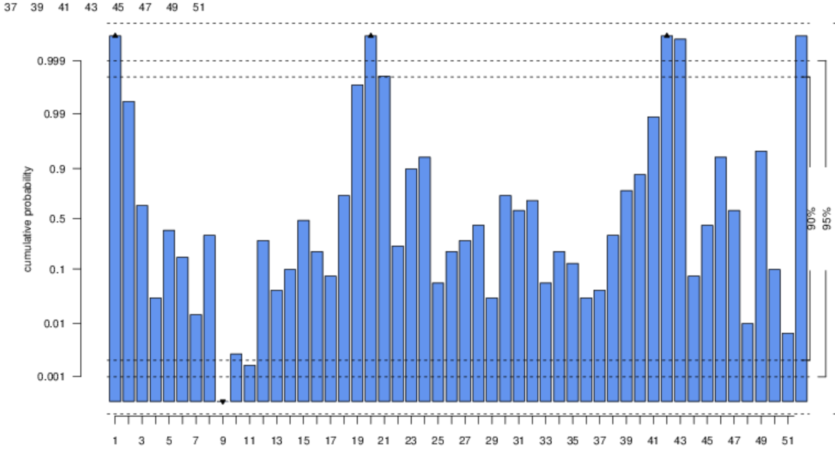
Fučkar et al. (2014)

Bias correction and calibration

Rank histogram for ECMWF S4 predictions of 10 m wind speed over the North Sea for DJF starting in November. Raw output (top), bias corrected (simple scaling, left) and ensemble calibration (right). One-year-out cross-validation applied.



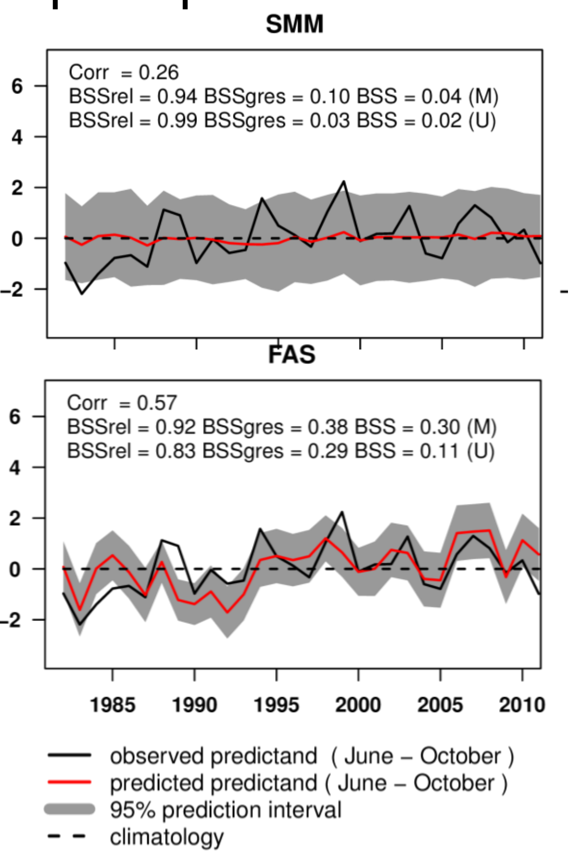


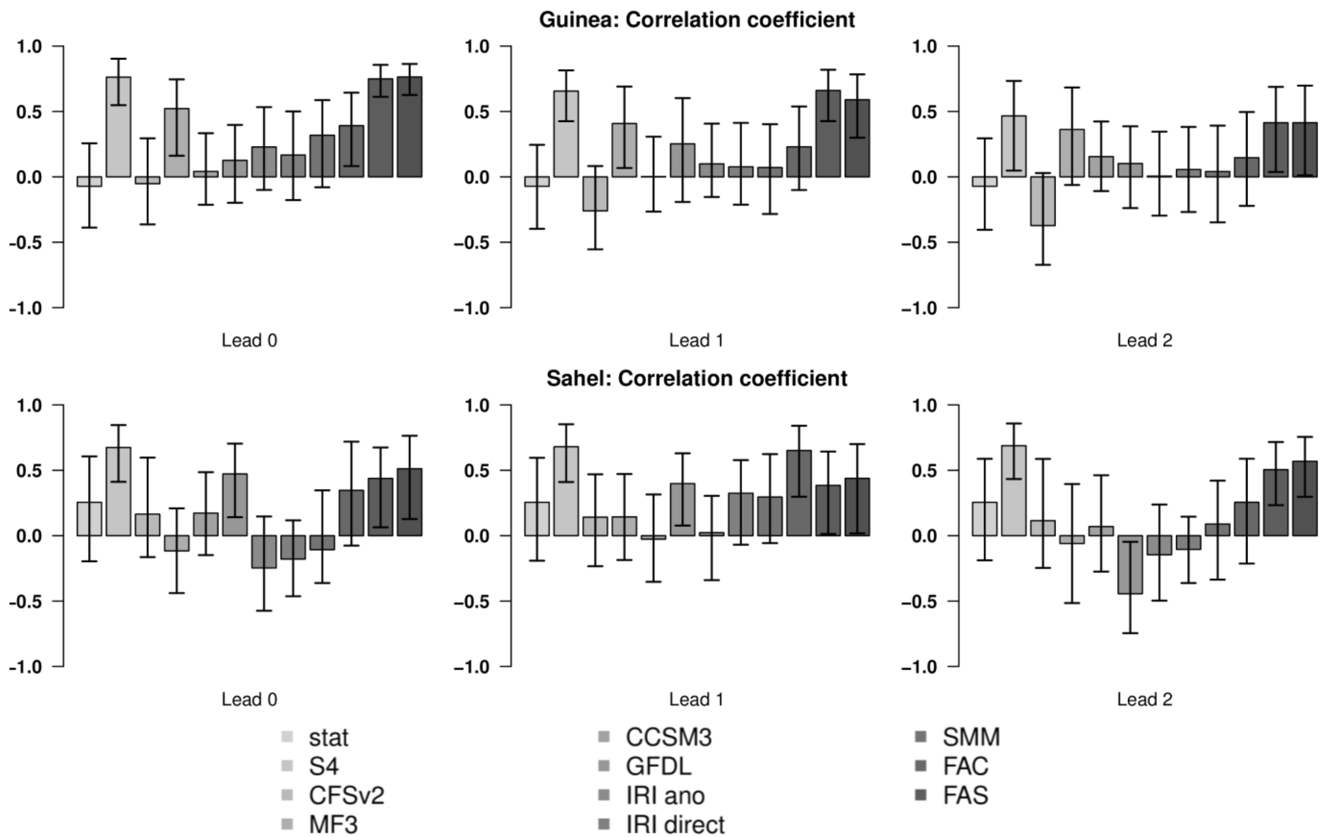


V. Torralba (IC3)

Calibration and combination: WAM

(Left) Multi-model seasonal predictions of Sahel precipitation, including its intraseasonal variability from June to October, started in April. (Right) Correlation of the ensemble mean prediction for Guinean and Sahel precipitation. *Reliability is fundamental for climate services.*





Rodrigues et al. (2014)

Conclusions

Work should be done to:

- understand how the initialisation affects the simulated variability
- distinguish between initial shock and drift
- investigate new methods to perform bias correction
- distinguish between the stationary and non-stationary components of the error
- assess the impact of the initial shock on the skill
- consider the sensitivity of the three terms to the parameter and model uncertainty
- move beyond typical evaluation and develop approaches to trace model errors back to their physical origin

WCRP Grand Challenges

- Grand Challenge on Regional Climate Information: What gaps in our scientific understanding and information, if addressed, would maximise the value content of regional climate information?
- Steering group: Clare Goodess (WGRC), Francisco Doblas-Reyes (WGSIP), Lisa Goddard (CLIVAR), Bruce Hewitson (WGRC), Jan Polcher (GEWEX & WGRC), supported by Roberta Boscolo (WCRP)